CLAIMS

We Claim:

1. A diaphragm pump assembly comprising:

a) a pump housing that defines a pumping chamber having an inlet to deliver pumpage to the chamber, a flexible diaphragm supported within the chamber to apply pressure to pumpage entering the pumping chamber, and an outlet to discharge pumpage from the pumping chamber;

b) a pump control module for effecting discharge and suction strokes in the diaphragm, said control module including:

i) an intermediate bracket secured to a diaphragm housing forming part of the pump housing;

ii) a fluid pressure operated actuator attached to said intermediate bracket and including an actuating rod extending through said intermediate bracket and operatively connected to said diaphragm;

iii) a direction control valve for selectively directing fluid pressure to said pumping chamber during a discharge stroke and to a lower chamber forming part of said actuator, during a suction stroke;

iv) an intermediate valve for controlling said direction valve;

v) a pair of pressure regulators for adjusting the fluid pressure applied to said pumping chamber and to said lower chamber during a discharge stroke and suction stroke, respectively; and,

vi) a pair of end-of-stroke sensors for sensing the limits of movement for said actuating rod.

2. The diaphragm pump assembly of claim 1, wherein said actuator comprises a fluid pressure operated cylinder.

3. A pump control for controlling the operation of a diaphragm pump, the diaphragm pump including a pump housing supporting a flexible diaphragm that divides the pump housing into a pumping chamber and a pumpage chamber, the pump control comprising:

a) an intermediate housing adapted to be mounted to said pump housing and including a passage for communicating fluid under pressure to said pumping chamber;

b) a fluid pressure operated actuator attached to said intermediate housing and including an actuating member operatively connected to said diaphragm;

c) first and second end-of-stroke sensors for sensing predetermined limits of movement of said actuating member;

d) a direction control valve for selectively directing fluid under pressure to said pumping chamber during a discharge stroke and to a retraction chamber forming part of said actuator, during a suction stroke;

e) a detent valve responsive to said end-of-stroke sensors for controlling said direction control valve, said detent valve including a valve element shiftable between first and second positions, said valve element maintaining a given position until a change in a fluid pressure signal caused by one of said end-of-stroke sensors is sensed.

4. The pump control of claim 3 further comprising first and second pressure regulators for adjusting the fluid pressure applied to said pumping chamber and said retract chamber during a discharge stroke and a suction stroke, respectively.

5. The pump control of claim 3 wherein said detent valve inhibits a change in state of said direction control valve until one of said end-of-stroke sensors senses a limit of movement in said actuating member.

6. The pump control of claim 3 further comprising a port, connectable to a chamber forming part of said actuator which when pressurized, urges said actuating member in a discharge stroke direction.

7. The pump control of claim 3 further including a replaceable adapter member for adapting said pump control to pump housings of various configurations.

8. The pump control of claim 3 wherein said directional control valve, intermediate valve, intermediate housing and regulator valves form a unitary sub-assembly which includes fluid passages that are fluidily interconnected when said intermediate valve, directional control valve, intermediate housing and regulator valves are secured together without the need of external fluid conduits.

9. A method for operating a diaphragm pump having a pump housing and a diaphragm located within the pump housing that divides the housing into a pumping chamber and a pumpage chamber, comprising the steps of:

a) providing an actuator, including an actuating rod, operatively coupled to said diaphragm;

b) selectively applying a fluid pressure to said pumping chamber to cause said diaphragm to move in a discharge direction;

c) sensing when said actuating rod reaches a predetermined discharge stroke position and generating a pressure differential across a directional control valve to cause it to change position;

d) changing the operational state of a directional control valve in response to a change in position of a detent valve in order to terminate the communication of fluid pressure to said pumping chamber;

e) applying fluid pressure to a retraction chamber forming part of said actuator in order to move said actuating rod in a suction stroke direction;

f) sensing when said actuating rod reaches a predetermined suction stroke position and generating a second pressure differential which shifts said detent valve to its first position whereby fluid pressure to said retraction chamber is terminated and fluid pressure is again communicated to said pumping chamber.

10. The method of claim 9 further comprising the step of communicating fluid pressure to a discharge stroke chamber forming part of said actuator when fluid pressure is being communicated to said pumping chamber.

11. The method of claim 10 further comprising the step of separately regulating the fluid pressure applied to said pumping chamber and to said retraction chamber, during the discharge and suction strokes of said actuating rod to thereby separately adjust the rate at which said diaphragm is driven in the discharge stroke and suction stroke directions.

12. A diaphragm pump assembly, comprising:

a) a pump housing and a flexible diaphragm supported within the housing for dividing the housing into a pumping chamber and a pumpage chamber, said pumpage chamber including a port for receiving pumpage from an inlet conduit during a suction stroke and for discharging pumpage to an outlet conduit during a discharge stroke;

b) a pump control module for controlling the discharge and suction strokes of said diaphragm, said control module including:

i) a fluid pressure operated actuator, including an actuating rod operatively connected to said diaphragm for exerting forces on said diaphragm during said suction stroke;

ii) an intermediate member mounting said actuator to said pump housing in an operative position;

iii) said intermediate member also mounting a direction control valve and a detent valve;

iv) said direction control valve operative to selectively direct fluid under pressure to said pumping chamber during a discharge stroke and to said actuator during a suction stroke;

v) said detent valve operative to control said direction valve in response to fluid pressure signals received from end-of-stroke sensors that sense at least two limits of movement of said actuating rod.

13. The diaphragm pump of claim 12 further including a pair of pressure regulators for adjusting the pressure of fluid applied to said pumping chamber and said retraction chamber during the discharge stroke and said suction stroke, respectively.

14. The diaphragm pump of claim 13 wherein said pressure regulators are separately adjustable in order to separately adjust the rate of movement of said diaphragm during said suction and discharge strokes.

15. The diaphragm pump of claim 12 wherein said actuator includes an actuator chamber which when pressurized applies a force to said actuating rod which tends to move said diaphragm in a discharge stroke direction and said pump control module is operative to supply fluid under pressure to said actuator chamber when pressurized fluid is being supplied to said pumping chamber.

16. The diaphragm pump of claim 12 wherein said detent control valve is responsive to pressure differentials generated by said end-of-stroke valves and said direction control valve is responsive to pressure differentials generated by said detent valve.

17. The diaphragm pump of claim 14 wherein at least one of said pressure regulators communicates directly with a source of pressurized fluid to which said pump control module is connected to.

18. The diaphragm pump of claim 14 wherein said separately adjustable pressure regulators communicate directly with a source of pressurized fluid for said control module.

19. A diaphragm pump assembly comprising:

a) a pump housing that defines a pumping chamber having an inlet to deliver pumpage to the chamber, a flexible diaphragm supported within the chamber to apply pressure to pumpage entering the pumping chamber, and an outlet to discharge pumpage from the pumping chamber;

b) a pump control module for effecting discharge and suction strokes in the diaphragm, said control module including:

i) an intermediate bracket secured to a diaphragm housing forming part of the pump housing;

ii) a pneumatically operated actuator attached to said intermediate bracket and including an actuating rod extending through said intermediate bracket and operatively connected to said diaphragm;

iii) a direction control valve for selectively directing air pressure to said pumping chamber during a discharge stroke and to a retract chamber forming part of said actuator, during a suction stroke;

iv) an intermediate valve for controlling said direction valve;

v) a pair of end-of-stroke sensors for sensing the limits of movement for said actuating rod.

20. The diaphragm pump assembly of claim 19 further comprising a pair of pressure regulators for adjusting the level of air pressure applied to said pumping chamber and to said retract chamber during a discharge stroke and suction stroke, respectively.

21. The apparatus of claims 1-18 wherein said fluid pressure is air pressure.